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Behavioural investigations into uncertainty perception in service exchanges: Lessons from dual-processing theory

Abstract:

Uncertainty perception is a core issue as it determines decision making and behaviour. Different organisations can perceive uncertainty differently based on contingencies in their environment and their capabilities. Uncertainty perception is also an individual characteristic as it is influenced by experience and knowledge. Based on dual-processing theory, this paper proposes an analysis method for assessing both explicit and implicit uncertainty perception depending on the individual's use of tacit or explicit knowledge. Analysing two industrial case studies of service relationships, this paper investigates the perceptions of three uncertainty types: environmental, relational and organisational uncertainty. The findings suggest that implicit uncertainty perception is prevalent and that uncertainty types are inter-related meaning that one uncertainty type can give rise to another one. Thus, this paper contributes to the literature in three major areas: First, showing the relative importance of the three uncertainty types in inter-organisational relationships complements the literature as existing approaches tend to focus on one uncertainty type such as environmental uncertainty. Second, the different uncertainty types are interrelated in inter-organisational relationships showing that one company's perception of one uncertainty type can cause the partner to perceive another uncertainty type. Finally, a novel method for assessing uncertainty perception is demonstrated.

Keywords: uncertainty perception, human behaviour, qualitative expressions; communication; dual-processing theory

1. Introduction

Scarce resources such as product-specific knowledge increase the benefits of inter-organisational relationships as an important source of competitive advantage (Squire et al. 2009). Inter-organisational relationships refer to the strategic cooperation between companies to create a collaborative advantage. Particularly for service exchanges such as when manufacturing companies provide the availability of their products offer potentially win-win situations as the customers can focus on their business needs and market offerings (Kreye et al. 2014; Baines & Lightfoot 2014). In such service exchanges, the provider offers support for the product function and its operation which can include maintenance and repair activities. Uncertainty is particularly important in these relationships as it is a core influence on corporate decision making and strategy building (Kreye et al. 2012) and the choice of governance mechanisms (Poppo & Zenger 2002). In fact, Sharma et al. (2007) highlight that perceived uncertainty is one of *the* most important characteristics in this context which can be observed in the high failure rates of many inter-organisational relationships (Hora & Dutta 2013).

Uncertainty refers to a potential deficiency in any phase or activity of the process, which can be characterised as not definite, not known or not reliable (Kreye et al. 2012). Uncertainty perception can be influenced by heuristics to enable “*quick reactions to signals, improbable as they may look, either by acting immediately or by gathering further data as quickly as possible*” (Paté-Cornell 2012, p.1830). Thus, uncertainty perception often differs from extant uncertainty highlighting the importance to investigate this issue in more depth. Decision makers may ignore uncertainty and hence be overconfident (Paté-Cornell 2012) or they may overestimate uncertainty (Harvey 2001). Thus, behavioural considerations are often of core importance and can manifest itself in e.g. unreasoned departures from decision rules (MacGillivray 2014).

Different approaches to measuring the uncertainty perception have been proposed. For example, Lawrence and Lorsch (1967), Duncan (1972), and Miles and Snow (1978) attempted to measure environmental characteristics such as the adequacy of information about a factor and the predictability of this factor. Another approach was proposed by Cannon and Perrault (1999) as a questionnaire, where companies estimate the uncertainty in their environment focusing on, for example, the significance of changes in the market. However, these measures have been found to be inconsistent and unreliable by independent follow-up studies (Tosi et al. 1973; Buchko 1994). One reason for this inconsistency can be found in different behavioural approaches to decision making as two systems of reasoning impact information processing: System 1 and System 2 (Sloman 2002; Sloman 1996). System 1 is responsible for associative reactions to situations via e.g. simplifications while System 2 defines rule-based thinking processes. Dual-processing theory states that both systems of reasoning can operate in parallel and lead to different perceptions of a situation with System 1 defining implicit and System 2 explicit reasoning (Sloman 1996). Existing measures tend to ignore the influence of the two systems of reasoning by measuring only explicit responses, ignoring the impact of implicit reasoning which can form an important foundation for managerial behaviour and decision making.

This paper aims at analysing the perceived uncertainty in inter-organisational relationships of a service exchange by including dual-processing theory. This paper presents a method for assessing both implicit and explicit uncertainty perception which is applied to two case studies focusing on inter-organisational service exchanges including provider and customers. Using interview transcripts of responses from service providers and their customers, the presented method utilises content analysis presenting keywords that indicate uncertainty perception. As such, this paper contributes to the literature in uncertainty

perception by offering an in-depth analysis of implicit and explicit reasoning of individual experts and organisations involved in inter-organisational relationships.

2. Theoretical background

2.1 Service exchanges

Many traditional manufacturing companies have added services to their business portfolio to extend their responsibility to the product's operation phase and engage in service exchanges with their customers (Baines & Lightfoot 2014; Kreye et al. 2014). This development has also been termed servitization and the combination of products and services is typically referred to as Product-Service Systems (PSS) (Lightfoot et al. 2013; Aurich et al. 2006). PSS offer the possibility of creating a more stable cash-flow, higher profit margins and closer customer ties (Baines et al. 2009). However, despite the potential benefits, many companies do not realize these advantages, often even obtain losses and fall into the "service paradox" (Gebauer et al. 2005). For every successful example, *"at least five cautionary tales remind us that manufacturing companies will most likely struggle to turn a profit from their service business"* (Reinartz & Ulaga 2008, p.91). One of the main challenges is the increased uncertainty in service exchanges arising from the nature of services and long life cycles (Kreye et al. 2014).

2.2 Uncertainty in service exchanges

Uncertainty can arise from various sources within and surrounding the inter-organisational relationship. One source can be the environment of the collaboration leading to *"the state of a person who perceives himself/herself to be lacking critical information about the environment"* (Milliken 1987, p.134). Influences can come from issues such as the technological development on the market leading to the possibility of obsolescence of the product or parts (Oosterhuis et al. 2011). Similarly, the availability of material, parts and tools necessary to perform the service activities may be uncertain in terms of quantity and/or timing

of supply (Fynes et al. 2004). Contradicting opinions exist on organisations' responses to this uncertainty as some organisations may attempt to create a more stable and predictable environment through coordination to create long-term relationships (Pfeffer & Salancik 1978), while may engage in opportunistic behaviour to ensure company survival (Gaur et al. 2011).

Another source of uncertainty can be the inter-organisational relationships as for example the cost of providing the service may be difficult to predict accurately (Kreye et al. 2014). Services require the joint input of both customer and provider which means that the provider's processes and cost are dependent on the customer's diligence, commitment and responsibility which may be unknown (Lewis & Brown 2012). This has been conceptualised as relational uncertainty which is the inability to predict the partner's future behaviour and the level of cooperation (Das & Bing-Sheng 1996). It is concerned with trust on the partner's capability and willingness to jointly solve problems (Ring & Ven 1994). Relational uncertainty can be influenced by the length of the cooperation as long-standing ties increase the trust between the cooperating partners and increases the confidence of actors on both sides and may thus reduce relational uncertainty (Bastl et al. 2012; Kreye et al. 2013). However, some shared information may be confidential which raises the possibility of information leakage to competitors or other unintended parties and other opportunistic behaviour (Zhao et al. 2013).

Other issues may arise from within the firm and refer to its capability to provide or receive the service. This is related to core service capabilities such as technical knowledge (Kreye et al. n.d.). Problems can arise from changes in staff and the loss of tacit knowledge as well as differences in perceptions of the service goal (Menor et al. 2002). The organisation may not have the information it needs to perform a task leading to task uncertainty (Lee & Veloso 2008). This can be mitigated by strong communications and coordination mechanisms

within the organisation (Galbraith 1977). In addition, the performance and achievement of organisational goals can be difficult to predict leading to misdistribution of resources (Das & Bing-Sheng 1996). Table 1 summarises these issues of inter-organisational relationships and presents the three types of uncertainty depending on the source of the issue as environmental, relational or organisational uncertainty. This conceptualisation will be used for the empirical investigations presented in this paper (see also Section 3).

<Please insert Table 1 about here>

2.3 Uncertainty perception and cognitive processing

To judge a person's perception of a situation, their cognitive processes form a useful basis. Dual-processing theory explains how people reason and process information in their decision making (Sloman 1996; Sloman 2002) and suggests that persons have two systems of reasoning: System 1 and System 2. System 1 explains associative reactions to situations and utilises intuitive and automatic processes such as the perception of regularities and causal relationships (Sloman 1996). An example is when we orient ourselves towards the source of a sound (Kahneman 2011). Thinking processes using System 1 are pragmatic, based on experience and belief and as such are often fast (Evans & Over 1996). As a result, the processes are implicit meaning that a person using System 1 is typically consciously aware of the outcome (i.e. the decision they made) but not the thinking process to obtain this outcome (Sloman 1996). This is caused by the use of implicit knowledge when processing information which means that no formal understanding of an issue itself is achieved but that the knowledge was acquired incidentally (Osman 2004).

In contrast, System 2 operates rule-based and includes deliberate and controlled processes which apply systematic rules. An example is arithmetic where numbers can be generated through the computation of mathematical rules (Sloman 1996). These processes are sequential, controllable, demanding and often slow leading the person using it to be

consciously aware of both the outcome and the thinking process (Sloman 1996). As such, System 2 refers to explicit processes.

Dual-processing theory highlights that both systems of reasoning can act together, contributing (at the same time) to a particular response or decision (Sloman 1996; Osman 2004). As such, processes in Systems 1 and 2 are linked and need to be investigated jointly. If a decision is based on both explicit and implicit thinking processes, the decision-making process cannot be analysed by focusing on either of them but needs to consider both systems of reasoning. This research utilises the concepts from dual-processing theory as implicit uncertainty perception means that the decision maker has no formal understanding of the lack of knowledge (i.e. uncertainty) s/he has. As such, information processing utilising System 1 leads to an implicit perception of uncertainty while System 2 to an explicit perception of uncertainty.

Implicit and explicit uncertainty perception tend to be expressed differently by decision makers as suggested by Windschitl and Wells (1996). As such, statements such as “not sure” or “expected” indicate that a person is uncertain about a specific decision, task or context but may not be able to assign probabilities to the available options. Thus, the use of specific uncertainty expressions can indicate the decision maker’s perception of uncertainty (Windschitl & Wells 1996). Uncertainty expressions that indicate the use of System 2 suggest an explicit perception of uncertainty while uncertainty expressions that indicate the use of System 1 show an implicit perception of uncertainty. This differentiation will be used in this paper to investigate uncertainty perception in service exchanges.

3. Research method

This research adopts an exploratory approach to investigate uncertainty perception in service exchanges to build theory and further understanding. Service exchanges are dependent on contextual factors such as the industrial sector or the collaborating organisations. Thus,

empirical investigations into uncertainty perception need to consider these characteristics in the chosen method. This paper applies a multiple case-study approach as a suitable method for the following three reasons. Case studies offer the possibility of investigating a context-specific phenomenon (Barratt et al. 2011). The environmental influences on the cases can be identified and analysed ensuring validity and rigour of the case findings. Second, case studies offer rich data that enable an in-depth analysis of the studied phenomenon (Eisenhardt 1989). Thus the uncertainty perceived by the organisations and individuals can be investigated in-depth identifying the links and reasons. Third, case studies are useful research methods when there is a lack of extant theory explaining the investigated phenomenon (Eisenhardt & Graebner 2007). As explained above, current theoretical explanations of uncertainty perception in inter-organisational collaborations show limitations with regard to uncertainty perception. Utilising multiple cases allows us to triangulate our findings and improve rigour of the presented findings (Lewis 1998).

3.1 Case studies

Two industrial case studies are presented; both set in the electronics sector within the UK to allow for cross-case comparison due to similarities in the contextual settings. The electronics sector is particularly useful for the presented investigation as it sees an increasing trend towards inter-organisational collaboration in terms of service provision for products due to global pressures to improve product performance and reduce energy use and as such is representative for the type of inter-organisational collaboration being studied for this research. The unit of analysis is the service agreements between service providers and their customers. The case studies were chosen during discussions with the service providers based on research requirements. One of the requirements was that both provider and customer sides could be included in the data collection leading to the choice of successful inter-organisational collaboration which enabled the researcher to investigate both the service providers' and

customers' experiences with each other. Thus, the cases were selected as polar extremes in the field (Lewis 1998) based on positive relationships with open sharing of information and strategic considerations.

Both service providers were internationally operating manufacturing companies that produced electronic products for water treatment such as actuators and pumps. The customers were operated locally and provided services to businesses and private consumers. Both customers had some experience with receiving services prior to the contracts chosen for this research; however from different service providers. The two cases differed in the level of experience as the studied organisations had been involved in their agreements for three and six years respectively. Investigating multiple cases in similar economic settings but with differences in organisational experience enriches the discussion presented in this paper through cross-case comparison. This level of similarity offers an ideal basis for comparing the findings and building theory (Lewis 1998) as well as mitigate the influence of observer bias on the obtained findings (Voss et al. 2002).

3.2 Data collection

Semi-structured interviews were conducted with different actors from the service provider and customer. This allowed for a detailed discussion of the interviewees' experiences in the service contract, offered the possibility to clarify assumptions and misunderstandings and was a flexible and adaptable basis for data collection. The interviewees were chosen based on their experience and levels of involvement in the case study contracts. Eleven and 16 persons were interviewed for Case A and B respectively as depicted in Table 2. The interviews were collected in 2013, held face-to-face and one-to-one to allow for informal discussions, create a friendly and non-threatening interview atmosphere. In addition, secondary data including financial reports, service contracts and service reports was collected to validate findings, eliminate and improve the internal and external validity and case study rigour (Lewis 1998).

The interviews took between 20 and 40 minutes, were recorded and transcribed for analysis. Due to technical difficulties or the interviewee's wish, two interviews of Case B (Mechanical engineer and Service manager 2) could not be recorded or these interviews, the researcher took extensive notes including quotes and phrases used by the interviewees to compensate for the lack of recording to complement the transcripts. The non-transcribed interviews are marked throughout the presentation of the findings.

<Please insert Table 2 about here>

The interviews followed a prepared protocol to guide the discussion and ensure rigour in the data collection. Interviews with open-ended questions have been highlighted as a suitable method to assess uncertainty perception (de Bruin et al. 2002). The interviewees were encouraged to reflect on the service exchange, their expectations, critical incidents throughout the collaboration - both positive and negative, their personal evaluation of the performance and lessons learnt. The interviews did not specifically discuss uncertainty or the interviewees' uncertainty perception as this was found to bias interviewees in their discussions and thus reduce the usefulness of the gathered findings (Kreye et al. 2013). This research aimed at investigating the interviewees' use of both systems of reasoning and specifically heuristics (part of System 1 reasoning) have been described as impossible to be assessed directly, as this would bias the respondents' assessment of uncertainty, leading them to resolve some of their perceived uncertainty (de Bruin et al. 2002). Thus, an indirect approach to assessing uncertainty perception was applied for data collection.

3.3 Data analysis

The interview transcripts were analysed with content analysis to offer an objective and systematic tool for data analysis (Matthews & Ross 2010). This consisted of two stages: an initial keyword search and a subsequent in-depth analysis of the keyword context and meaning. Stage one- the keyword search – focused on terms indicating explicit and implicit

uncertainty perception. The list of uncertainty terms was compiled through an iterative process moving between theory and empirical findings (Strauss & Corbin 1990). An initial list of terms emerged from the literature and differentiated terms indicating explicit and implicit uncertainty perception based on the following reasoning. Various concepts have been discussed in direct connection to the concept of uncertainty since the very early stages of academic research in the field such as include risk (Knight 1921), variability (Downey et al. 1975); chance (Langer & Roth 1975) and probability (Keynes 1921) We assume these concepts at the core of a discussion about uncertainty and thus indicating a level of explicit uncertainty perception. The nature of this link to uncertainty has been in some cases a much debated area and is outside of the scope of this paper.

In contrast, other concepts have entered the discussion of uncertainty more recently and we assume them thus to be more indirectly linked and thus indicate implicit uncertainty perception. These concepts include change (Dequech 2011), expectations (Zimmermann 2000), forecast and estimates (Goodwin 2002) and experience (Barnett & Breakwell 2001). These concepts are more tangentially linked to uncertainty and indicate thus implicit uncertainty perception. Table 3 lists the terms utilised for the content analysis to indicate uncertainty perception.

<Please insert Table 3 about here>

The measurement of uncertainty perception is analysed using a normalised measure. As such, the use of the terms listed in Table 3 was counted for each interviewee resulting in an absolute number of explicit and implicit uncertainty term uses. To allow for comparison of individuals and organisations as well as cross-case comparison, this measure was normalised over the length of the interview. Other normalisation approaches exist, such as the number of words spoken or per shortened phrases (Payne 1976; Gero & Tang 2001), each with their own advantages and shortcomings. Due to the varying length of semi-structured interviews, we

chose this as a suitable normalisation approach for the purpose of this research. As such, the results of stage one of the analysis are presented in “times per minute”.

For stage two of the analysis, the interview transcripts were coded into major thematic categories informed by our research question and comprehensive literature review (Strauss & Corbin 1990). More specifically, we utilised the three uncertainty types - environmental, relational and organisational uncertainty - as the major codes for data analysis to identify the source of the perceived uncertainty in our cases. This was combined with the analysis of uncertainty terms from Stage 1 to identify the prevalence of the three uncertainty types. Using this method for data analysis enables an investigation and comparison of different individuals and organisations and draw conclusions on relationships between phenomena (Krippendorff 1980).

4. Results

In this section, the case study contexts are described before the findings for the uncertainty perception measures (stage one) and the perceived uncertainty types (stage two) are outlined.

4.1 Case study contexts

Both case contracts focused on the maintenance of the service provider’s products, inspecting the condition and repairing faults and breakdowns. The aim of both contracts was to “*give the support the customer requires and to (...) [minimise] downtime*” (Sales manager, SP B). In both cases, the studied service exchange was the first contractually agreed service between the providers and customers as previously the repairs and maintenance had been handled on a case-by-case basis when faults occurred. This helped them to gain experience with their customers as highlighted by the Sales manager (SP A): “*so before we had this contract, we had this trial run which helped us look at volume, how much work, response time, expectation. So it gave us a little feel about the contract.*” It also offered the chance to build a personal relationship between the service engineers of service providers and their customers

as described by the Service manager 2 (SP B) “[the customer] just rung me up or whatever or he might ask for a bit of advice on the phone”.

The differences between the two cases stemmed from the level of prior experience between service provider and customer which was three years in Case A six years in Case B. In addition, each case was characterised by regulations such as registering the work prior to the visit. However, for Case A, this was not enforced for every service visit as the Senior service engineer (SP A) explained: “*sometimes when you get there, if the customer is with you all the time, they will not stipulate a permit to work.*” In contrast, for Case B the regulations were enforced for every service visit. In this case, the regulations focused on communicating information regarding the service engineer who will carry out the work as the Service coordinator (SP B) described: “*there are rules and regulations we have got to follow. (...) [We register] the name of the engineers (...) and specific dates that so they can get booked in with security at the site.*” Thus, the two cases differed with regard to the length of experience of collaborating partners and the enforcement of customer-specific processes and regulations.

4.2 Individual uncertainty perceptions

Large individual differences in uncertainty perception could be observed as particularly in Case A, the measurements varied between 2.13 (Service manager, SP A) and 8.45 times per minute (Electrician 1, C A). In contrast, Case B showed smaller differences in uncertainty perception as the measurements varied between 5.73 (Eng supervisor, C B) and 11.50 (Service coordinator, SP B). Implicit uncertainty perception was prevalent for all interviewees while there were also individual differences for the ratios of explicit to implicit expressions. For Case A, the ratio varied between 2.0%-98.0% (Service engineer, SP A) and 20.63% - 79.37% (General manager, SP A). This means that the Sales manager was able to express his perceived uncertainty more explicitly while the Service engineer was not. In contrast, Case B showed a lower variation for the explicit-implicit distribution, namely between 5.26%-

94.74% (Service planner, SP B) and 16,21%-83.79% (General manager, SP B). In other words, the uncertainty perceptions varied a lot more for Case A than for Case B, which could be due to the length of the arrangement, as the relationship of Case A had been in place for only three years while the relationship for Case B for six years. Figure 1 shows the perceived uncertainty for service provider and customer for Case A (Figure 1a) and Case B (Figure 1b).

<Please insert Figure 1 about here>

The possible reasons for the individual differences in uncertainty perception are manifold such as the nature of the interviewees' tasks, the length of their experience or individual biases and heuristics. For case A, Electrician 1 (C A) with the highest uncertainty perception had similar tasks as for example Service engineer, Sr service engineer and Electrician 2, who all had much lower values for uncertainty perception. In contrast, for Case B, the Service coordinator as a member of the back office had highest uncertainty perception, which might be due to the fact that SP B had recently decided to rotate the back-office staff around different tasks to increase the flexibility when dealing with different customers and service agreements. In addition, for both cases the service managers showed relatively low levels of uncertainty perception which could be due to their tasks that included the management of uncertainty through for example solving problems of service engineering and back office staff. Thus, the nature of the interviewee's tasks could be one possible explanation for the observed differences in uncertainty perception. Another possible explanation could be the length of experience in the job. Electrician 1 had more than 20 years of experience while the other engineers and electricians of Case A had less than 10 years of experience each. This suggests that an individual's experience could increase their perceived level of uncertainty, being more perceptive to the possible development in the job. However, the length of experience alone cannot explain the observed differences as the Service manager for Case A (very low uncertainty perception) did also have more than 20 years of experience in his job.

Thus, it can be concluded that individual differences in uncertainty perception may be influenced by a combination of task, length of experience and individual biases.

4.3 Perceived uncertainty types

The results showed a strong difference between the prevalent uncertainty types in the two cases and between the companies. In Case A, the customer perceived organisational uncertainty while the service provider perceived relational uncertainty as the most prevalent type. The customer's organisational uncertainty was connected to the development of new communication processes and organisational structure as highlighted by for example Electrician 2 (Customer A): *"At (our company), there are so many rules and regulations, before they spend money, they just take so long [to make decisions]"*. This was also related to the evaluation of the performance in the contract as highlighted by for example Electrician 1 (Customer A): *"in certain instances, it does take quite a while, but I do not think it is the fault of [the SP A], I think it is [our] process (...) it is the whole paperwork side of it that slows it down, not [the SP A]"*.

From the Service provider's perspective, the customer's organisational uncertainty seemed to translate into relational uncertainty as they could not trust all the information and communications from the customer. They particularly did not trust the information they received about product details or positioning as highlighted by the Sales manager (SP A): *"[the asset inventory] is meant to be updated as products are installed onto assets. (...) so when it does break down, they should be able to go onto their system and give us the data. And that is incorrect, it is not accurate"*. This link between customer's organisational uncertainty and service provider's relational uncertainty suggests that by supporting the customer in making their internal processes more effective and efficient; the service provider could reduce their own perceived uncertainty leading to benefits for themselves.

In comparison, Case B showed the opposite picture. Here, relational uncertainty was prevalent for the customer while organisational uncertainty was prevalent for the service provider. In this case, relational uncertainty arose because the customer had a specific protocol that needed to be followed during service visits. This was due to the rigorous site security and included registration of engineers and sharing of information. This could cause uncertainty as communications about service visits might not always reach their destination. However, the service engineers learned how to mitigate this issue as highlighted by Service engineer 2 (SP B): *“Personally, I always phone up one or two days prior to the visit just to make sure that everything has been put in place and they are expecting me”*. Further, all the service engineers from the Service provider mentioned the customer’s Service manager and his personality as he was the main contact person on the customer side.

“I quickly established that at 10 o’clock in the morning, the [staff at Customer A] like to go for a tea break. (...) So, we go to the café around the corner and I tend to find that if you buy [Service manager, Customer A] breakfast, the rest of the day, he will leave you alone. So if the amount you saved for £5, it is sure bliss” (Service engineer 1, SP).

The organisational uncertainty of the service provider received high measures, particularly of implicit uncertainty terms for the back office staff such as the Administrator 1, the Service coordinator and the Office manager of the SP. This suggests that the decision of the Service provider to rotate their back-office staff through different tasks created uncertainty related to the internal company processes as the staff felt unsure about for example their tasks, key contact persons within the company and processes for delivering the service. This was mentioned by the Service engineer 1 (SP B) as: *“I do the best I can but in the office, it is not always the same person planning the job.”* The purpose of this back-office rotation was to ensure flexibility in staff knowledge, highlighting the link between uncertainty and flexibility as managerial concepts. The organisational uncertainty of the SP B influenced the relationship between the two companies. As such, the personal relationship between the Service

provider's back-office and the customer was less developed which had an impact on the communications and relations. In addition, some of the customer's relational uncertainty was connected to the service provider's organisational uncertainty as highlighted by the Engineering supervisor (Customer B): *"You have had a change of personnel in the office, the service office recently or in the last year. (...) if you had the same person dealing with you all the time, they'd know exactly what I need. So it just makes it a little bit easier."* Figure 2 shows the measures for the uncertainty types as perceived within the service relationship for Case A (Figure 2a) and Case B (Figure 2b).

<Please insert Figure 2 about here>

Figure 2 shows that the overall perceived uncertainty in case B was higher than in case A. The most prevalent uncertainty types received total measures of around 4 mentions per minute (3.94 for organisational uncertainty of SP B and 4.32 for relational uncertainty for Customer B), while for case A these were much lower (2.41 for relational uncertainty of SP A and 3.12 for organisational uncertainty of Customer A). This is a surprising finding as the service relationship in Case B had been about twice as long as for case A which raised the expectation of lower uncertainty. This suggests that our current understanding of the development of uncertainty over time is still incomplete. It is pointed out that the measured uncertainty perception could also relate to positive experiences.

For example, statements such as "You could call him (Service manager 1 from SP) up and he would bend over backwards and help you out with anything" (Electrician 1, Customer A), *"I feel pretty confident with them"* (Technical manager 1, Customer A) or *"if he [C A's Contract manager] asks us to go to site, there is no way we could say no to him. Even if he asked us to go on Christmas Day, we would have to go"* (Service manager, SP A) were mentioned throughout the interviews. These statements indicate perceived relational uncertainty, but highlighted the trust in the partner's ability and general relationship. Thus,

uncertainty is not always connected to a problem or issue but can also highlight a positive experience.

5. Discussion

This paper presented an analysis of the uncertainty perceived by service provider and their customer in a service exchange. The findings revealed strong individual and organisational differences in the uncertainty perception depending on the context and nature of the inter-organisational relationship. The reasons could be for example the nature of the person's tasks, the length of their experience or individual biases. These have also been highlighted in the literature (Kahneman & Tversky 1982; Milliken 1987; Klein et al. 2006); however, our paper adds the in-depth analysis using real-world empirical data. In this context, a combination of the possible reasons was found to result in individual differences in uncertainty perception. Further, the findings highlight the prevalence of relational and organisational uncertainty in both cases and suggest that uncertainty types can be related across organisations. This adds to findings presented for example by Raja et al. (2013) who highlight the relational component as an important factor to creating added value. Specifically, the findings indicate that organisational uncertainty of one partner can cause relational uncertainty for the other partner. This means that current literature that focuses on one uncertainty type such as relational uncertainty (Krishnan et al. 2006) lack insights on the interrelationships between them and thus give incomplete suggestions for successful uncertainty management. We acknowledge that in-depth insights into specific uncertainty types are important for managerial decision making, however, a holistic analysis of the perception of the different uncertainty types can lead to the identification of strong opportunities as highlighted in this paper. The presented research highlights the importance of this interrelationship and suggests that uncertainty reduction efforts addressing one uncertainty type may have knock-on effects to other types.

The results were obtained by using a novel analysis method for assessing both explicit and implicit uncertainty perceptions in inter-organisational relationships. This was based on a mental framework linking a person's expressions to their perception, which formed a useful basis for the proposed analysis method. The method used the natural communication flow of the interviewees which means they did not need to be asked about their evaluation of the uncertainty in their organisations and market environments. It is suggested that this analysis method may be more useful than current approaches described in the literature as it addresses the difficulty of expressing an abstract concept such as uncertainty explicitly through direct measurements (Windschitl & Wells 1996). Instead, using a person's description of a situation offers the advantage of an indirect analysis of the terms that s/he uses in this description. Thus, more natural information and communication flow can be considered which enables the measurement of implicit uncertainty perception.

However, some points need to be mentioned when applying the proposed analysis method. First, terminology use tends to be context specific highlighting the importance of adjusting the list of analysed terms to the empirical context as exemplified in this paper. Second, the analysis method relies on a person's natural speech in discussions and thus depends on individual communication characteristics such as talking speed and level of information richness. Individual differences can impact the measured perception. To identify the extent of this factor, a test analysis of absolute values (prior to normalisation) was conducted and showed the same patterns as the normalised analysis discussed in this paper. Thus, talking speed and information richness are contributing factors but showed minor impacts for the proposed analysis method. Third, the proposed analysis method relied on spoken terms meaning that other forms of communication were ignored. Particularly, gestures and mimics can communicate rich information in personal exchanges (Dael et al. 2013). Adding this further level to the analysis of uncertainty perception would further enrich

the insights. This may be particularly applicable to e.g. observation studies, where gestures and other activities are recorded. For the presented study, the impact of such information can be assumed to be relatively low as the data was collected through interviewing.

Findings showed that implicit uncertainty perception was prevalent for all participants. This indicates that existing approaches that measure uncertainty through explicit questionnaires (Cannon & Perreault 1999; Poppo & Zenger 2002) and quantitative assessments (Lawrence & Lorsch 1967; Duncan 1972; Miles & Snow 1978) investigate only a minor part of the perceived uncertainty as it ignores the use of implicit knowledge. This may explain some of the inconsistencies found in existing uncertainty measures (Tosi et al. 1973; Buchko 1994). Furthermore, this explains the differences between extant and perceived uncertainty which manifest themselves as overconfidence or over caution (Paté-Cornell 2012; Harvey 2001) as implicit uncertainty perception could lead to limited consideration in decision making when compared to explicit uncertainty perception. As such, further validation of the findings is needed. However, the described findings highlight that the proposed method could be more useful in measuring uncertainty perception and give a more realistic and unbiased result.

The presented research has the following limitations. The measured uncertainty perceptions did not include any judgment of the impact of this uncertainty, i.e. whether experienced was positive or negative. In other words, it may not be advantageous to reduce perceived uncertainty for decision making. Further investigations to the individuals' and organisations experience of uncertainty would clarify this issue and enable stronger suggestions on uncertainty management. Furthermore, the both cases focused on polar extremes as successful service relationships. Complementing the presented results by investigating opportunistic relationships could offer further insights into the topic. Moreover, focusing on one industrial context limits the generalizability of the findings. The results show

in-depth insights for the UK electronics sector and is thus aligned with the contingency approach that highlights the dependency on research and business contexts (Barratt et al. 2011). However, further research is needed to expand these insights. Case study research is often associated with observer bias and subjectivity in interpreting the findings. These limitations were mitigated by presenting multiple cases to limit the influence of observer bias on the reported findings (Voss et al. 2002). In addition, the interview data was triangulated with secondary data to improve the reliability and limit the influence of subjectivity on the analysis. Finally, limitations apply to the proposed analysis method. First, it used verbalised data by the study participants which has been criticised in the psychology literature particularly when participants were asked to describe their own rationality of actions and decisions taken (Ericsson & Simon 1984). In contrast, the approach taken in the presented research was for the participants to describe their experience in the service relationship in general rather than their behavioural processes. This approach was chosen to mitigate the mentioned shortcomings of verbalised data.

6. Conclusions

This paper presented an analysis the perceived uncertainty in inter-organisational relationships of a service exchange for both provider and customer. An analysis method was proposed for assessing both explicit and implicit uncertainty perception based on dual-processing theory. Applying this method to two industrial case studies in the UK electronics sector, the findings revealed four main points. First, uncertainty perception showed strong individual differences suggesting that it is influenced by individual characteristics such as the nature of the person's tasks.. Second, implicit uncertainty perception was found to be prevalent indicating that most of the uncertainty in inter-organisational relationships is perceived using implicit knowledge and would not be captured through explicit measures. In other words, approaches such as questionnaires ignore implicit processes and thus the core

part of uncertainty perception. Indirect methods such as the one presented in this paper could offer a more accurate understanding of uncertainty perception. Third, organisational uncertainty and relational uncertainty were found to be prevalent. This suggests that core issues in service exchanges arise from within the collaborating organisations and/or from the relationship. Fourth, the different uncertainty types were found to be interrelated as, for example, perceived organisational uncertainty for one cooperating partner influenced the perceived relational uncertainty of the other partner. This suggests that focusing analyses and theoretical explanations on one specific uncertainty type is an unsuitable simplification of the inter-organisational relationship as it ignores the knock-on effects of uncertainty perception between different types.

This paper contributes to the literature in multiple ways. An analysis of the relative importance of the three uncertainty types in inter-organisational relationships as perceived by the service provider and their customer complements the literature as existing approaches tend to focus on one uncertainty type such as environmental uncertainty. As such, the presented research provides insights into the nature of collaboration and its impact on service innovation through perceived uncertainty. Further, the interdependencies between the uncertainty types was analysed showing that one company's perception of one uncertainty type can cause the partner to perceive another uncertainty type. This contributes to the literature giving strong suggestions for collaborative uncertainty management. Third, the proposed analysis method enabled the measurement of both explicit and implicit uncertainty perception. Based on the theoretical foundations of dual-processing theory, the proposed method complements the literature as existing approaches focus on the assessment of explicit uncertainty perception through e.g. questionnaires. However, the findings highlight the need to include implicit uncertainty perception in the analysis.

The presented research has multiple managerial implications. Showing the prevalence of implicit perception of uncertainty for all individual participants and all four studied organisations, this research suggests that companies tend to misrepresent the level of uncertainty in their inter-organisational relationships leading to an underestimation of this uncertainty. In other words, in targeted uncertainty analysis activities, organisations ignore the uncertainty they implicitly perceive as they link this to their tacit (lack of) knowledge and not to their explicit knowledge and capabilities. Thus, they would not identify the need to improve their knowledge and capabilities and identify activities for uncertainty management. This links existing insights in uncertainty management and suggestions for management techniques to the limited uptake of these techniques by industry as they do not explicitly perceive the uncertainty and thus do not perceive the need to develop the necessary capabilities in uncertainty management. To overcome this shortcoming and develop actionable insights for practice, ways of influencing uncertainty perception, specifically the level of awareness from implicit to explicit, need to be found and translated into guidance for industry. Further, the link between organisational uncertainty of one organisation and relational uncertainty for the second organisation in the inter-organisational relationship suggests the advantage for jointly improving processes to cooperatively reducing uncertainty. For example, in the case of high organisational uncertainty of the customer, the service provider has an incentive to support the improvement of customer internal processes and procedures as this would in turn reduce their own perceived relational uncertainty. Thus, this research highlights the incentives for cooperative behaviour beyond the strategic partnership as this reduces uncertainty for both parties. Finally, the effect of uncertainty perception on service innovation can be utilised to identify suitable new service offerings that create value for the customer. For example, in Case A the service provider can help customer with their internal processes of storing and communicating information which would reduce the

customer's organisational uncertainty while also benefitting the providers perceived relational uncertainty.

The presented work points towards important suggestions for further research to enrich the discussion, to deepen the investigations and to broaden the applicability of the presented results. First, links between the presented method for measuring uncertainty perception and existing measures through e.g. questionnaires need to be investigated. Existing explicit measures of environmental uncertainty have been found to be inconsistent; however, as they have been used in various research contexts, their link to the method presented in this paper needs to be studied in more detail to identify advantages and disadvantages. Second, implicit uncertainty perception needs further investigation to identify how it impacts decision making and strategic choices and knowledge sharing activities. Thus, approaches to influencing the level of explicitness of uncertainty perception could form a useful tool to increase the accuracy and consequently improve the decision making and knowledge sharing within and between organisations. Third, the proposed analysis method needs to be validated further by applying it to different contexts and research methods for methodological triangulation. This paper offers initial insights on the usefulness and applicability and further work needs to elaborate on this. For example, the analysis method can be used for data analysis of observation studies where the researcher does not interact with the participants, which encourages more natural discussions and conversations. Fourth, further research needs to investigate link between perceived and extant uncertainty. The presented research measured the extent of perceived uncertainty by individuals and organisations and further work needs to identify the links to extant uncertainty and issues such as the uptake of uncertainty management techniques, the severity of different uncertainty types and their impact on managerial decision making. This will further current understanding as it builds a closer link to extant academic insights and industrial practice in uncertainty management.

References

- Aurich, J.C., Fuchs, C. & Wagenknecht, C., 2006. Life Cycle Oriented Design of Technical Product-Service Systems. *Journal of Cleaner Production*, 14(17), pp.1480–1494.
- Baines, T. & Lightfoot, H.W., 2014. Servitization of the manufacturing firm: Exploring the operations practices and technologies that deliver advanced services. *International Journal of Operations & Production Management*, 34(1), pp.2–35.
- Baines, T.S. et al., 2009. The Servitization of Manufacturing: A Review of Literature and Reflection on Future Challenges. *Journal of Manufacturing Technology Management*, 20(5), pp.547–567.
- Barnett, J. & Breakwell, G.M., 2001. Risk Perception and Experience: Hazard Personality Profiles and Individual Differences. *Risk Analysis: An International Journal*, 21(1), pp.171–178.
- Barratt, M., Choi, T.Y. & Li, M., 2011. Qualitative case studies in operations management: Trends, research outcomes, and future research implications. *Journal of Operations Management*, 29(4), pp.329–342.
- Bastl, M. et al., 2012. Buyer-supplier relationships in a servitized environment: An examination with Cannon and Perreault's framework. *International Journal of Operations & Production Management*, 32(6), pp.650–675.
- De Bruin, W.B. et al., 2002. What Number is "Fifty-Fifty"?: Redistributing Excessive 50% Responses in Elicited Probabilities. *Risk Analysis: An International Journal*, 22(4), pp.713–723.
- Buchko, A.A., 1994. Conceptualization and measurement of environmental uncertainty: An assessment of the miles and snow perceived environmental uncertainty scale. *Academy of Management Journal*, 37(2), pp.410–425.
- Cannon, J.P. & Perreault, W.D.J., 1999. Buyer-Seller Relationships in Business Markets. *Journal of Marketing Research*, 36(4), pp.439–460.
- Dael, N., Goudbeek, M. & Scherer, K.R., 2013. Perceived gesture dynamics in nonverbal expression of emotion. *Perception*, 42(6), pp.642–657.
- Das, T.K. & Bing-Sheng, T., 1996. Risk types and the inter-firm alliance structures. *Journal of Management Studies*, 33(6), pp.827–843.
- Dequech, D., 2011. Uncertainty: A Typology and Refinements of Existing Concepts. *Journal of Economic Issues*, 45(3), pp.621–640.
- Downey, H.K., Don, H. & Slocum Jr., J.W., 1975. Environmental Uncertainty: The Construct and Its Application. *Administrative Science Quarterly*, 20(4), pp.613–629.
- Duncan, R.B., 1972. Characteristics of Organisational Environment and Perceived Environmental Uncertainty. *Administrative Science Quarterly*, 17(1972), pp.313–327.

- Eisenhardt, K.M., 1989. Building theories from case study research. *Academy of Management Review*, 14(4), pp.532–550.
- Eisenhardt, K.M. & Graebner, M.E., 2007. Theory Building from Cases: Opportunities and Challenges. *Academy of Management Journal*, 50(1), pp.25–32.
- Ellsberg, D., 1961. Risk, Ambiguity, and the Savage Axioms. *The Quarterly Journal of Economics*, 75(4), pp.643–669.
- Ericsson, K.A. & Simon, H.A., 1984. *Protocol analysis: Verbal reports as data*, Boston, MA, USA: MIT Press.
- Evans, J.S.B.T. & Over, D.E.(), 1996. *Rationality and reasoning*, Hove, UK: Psychology Press.
- Fynes, B., de Búrca, S. & Marshall, D., 2004. Environmental uncertainty, supply chain relationship quality and performance. *Journal of Purchasing and Supply Management*, 10(4–5), pp.179–190.
- Galbraith, J.R., 1977. *Organization design*, Reading, MA, USA: Addison-Wesley.
- Gaur, A.S. et al., 2011. Environmental and Firm Level Influences on Inter-Organizational Trust and SME Performance. *Journal of Management Studies*, 48(8), pp.1752–1781.
- Gebauer, H., Fleisch, E. & Friedli, T., 2005. Overcoming the Service Paradox in Manufacturing Companies. *European Management Journal*, 23(1), pp.14–26.
- Gero, J.S. & Tang, H.-H., 2001. The differences between retrospective and concurrent protocols in revealing the process-oriented aspects of the design process. *Design Studies*, 22(3), pp.283–295.
- Goh, Y.M. et al., 2010. Uncertainty in Through-Life Costing - Review and Perspectives. *IEEE Transactions on Engineering Management*, 57(4), pp.689–701.
- Goodwin, P., 2002. Forecasting Games: Can Game Theory Win? *International Journal of Forecasting*, 18(3), pp.369–374.
- Grant, C.B., 2007. *Uncertainty and Communication: New Theoretical Investigations*, Basingstoke, UK: Palgrave Macmillan.
- Harvey, N., 2001. Improving Judgement in Forecasting. In J. S. Armstrong, ed. *Principles of forecasting: A handbook for researchers and practitioners*. New York, NY, USA: Springer Science & Business Media, pp. 59–80.
- Hora, M. & Dutta, D.K., 2013. Entrepreneurial Firms and Downstream Alliance Partnerships: Impact of Portfolio Depth and Scope on Technology Innovation and Commercialization Success. *Production and Operations Management*, 22(6), pp.1389–1400.
- Hurley, R.J., Kosenko, K.A. & Brashers, D., 2011. Uncertain Terms: Message Features of Online Cancer News. *Communication Monographs*, 78(3), pp.370–390.

- Kahneman, D., 2011. *Thinking, Fast and Slow*, New York, NY, USA: Farrar, Strauss and Giroux.
- Kahneman, D. & Tversky, A., 1982. Variants of uncertainty. *Cognition*, 11(2), pp.143–157.
- Kaplan, S. & Garrick, B.J., 1981. On the Quantitative Definition of Risk. *Risk Analysis*, 1(1), pp.11–27.
- Keynes, J.M., 1921. *A Treatise on Probability*, Macmillan.
- Klein, G., Moon, B. & Hoffman, R.R., 2006. Making Sense of Sensemaking 1: Alternative Perspectives. *Intelligent Systems, IEEE*, 21(4), pp.70–73.
- Knight, F., 1921. The Meaning of Risk and Uncertainty. In *Risk, Uncertainty, and Profit*. New York, USA: Harper Torchbooks, pp. 197–232.
- Kreye, M.E. et al., 2012. Approaches of Displaying Information to Assist Decisions under Uncertainty. *Omega - International Journal of Management Science*, 40(6), pp.682–692.
- Kreye, M.E., Newnes, L.B. & Goh, Y.M., 2013. Information availability at the competitive bidding stage for service contracts. *Journal of Manufacturing Technology Management*, 24(7), pp.1–33.
- Kreye, M.E., Newnes, L.B. & Goh, Y.M., 2014. Uncertainty in Competitive Bidding – A Framework for Product-Service Systems. *Production Planning & Control*, 25(6), pp.462–477.
- Kreye, M.E., Roehrich, J.K. & Lewis, M.A., Servitizing manufacturers: The relationship between service complexity and contractual and relational capabilities. *Production Planning & Control*, (in press).
- Krippendorff, K., 1980. *Content Analysis: An Introduction to its Methodology* F. G. Kline & S. H. Evans, eds., Beverly Hills, CA, USA: Sage Publications.
- Krishnan, R., Martin, X. & Noorderhaven, N.G., 2006. When Does Trust Matter to Alliance Performance? *The Academy of Management Journal*, 49(5), pp.894–917.
- Krishnan, R., Miller, F. & Sedatole, K., 2011. The Use of Collaborative Interfirm Contracts in the Presence of Task and Demand Uncertainty. *Contemporary Accounting Research*, 28(4), pp.1397–1422.
- Langer, E.J. & Roth, J., 1975. Heads I Win, Tails is Chance: The Illusion of Control is a Function of the Sequence of Outcomes in a Purely Chance Task. *Journal of Personality and Social Psychology*, 32(1975), pp.951–955.
- Lawrence, P. & Lorsch, J.W., 1967. *Organization and Environment: Managing Differentiation and Integration*, Cambridge, MA, USA: Harvard Business School Press.

- Lee, J. & Veloso, F.M., 2008. Interfirm Innovation under Uncertainty: Empirical Evidence for Strategic Knowledge Partitioning. *Journal of Product Innovation Management*, 25(5), pp.418–435.
- Lewis, M.A. & Brown, A.D., 2012. How different is professional service operations management? *Journal of Operations Management*, 30(1–2), pp.1–11.
- Lewis, M.W., 1998. Iterative triangulation: a theory development process using existing case studies. *Journal of Operations Management*, 16(4), pp.455–469.
- Lightfoot, H., Baines, T. & Smart, P., 2013. The servitization of manufacturing: A systematic literature review of interdependent trends. *International Journal of Operations & Production Management*, 33(11/12), pp.1408–1434.
- MacGillivray, B.H., 2014. Heuristics Structure and Pervade Formal Risk Assessment. *Risk Analysis*, 34(4), pp.771–787.
- Matthews, B. & Ross, L., 2010. *Research methods: A practical guide for the social sciences*, Harlow, UK: Pearson.
- Menor, L.J., Tatikonda, M. V & Sampson, S.E., 2002. New service development: areas for exploitation and exploration. *Journal of Operations Management*, 20(2), pp.135–157.
- Miles, R.E. & Snow, G.G., 1978. *Organizational strategy, structure, and process*, New York, NY, USA: McGraw-Hill.
- Milliken, F.J., 1987. Three types of perceived uncertainty about the environment: State, effect, and response uncertainty. *Academy of Management Review*, 12(1987), pp.133–143.
- Moore, R.E., 1966. *Interval Analysis* G. Forsythe, ed., New Jersey: Prentice-Hall, Inc.
- Oosterhuis, M., van der Vaart, T. & Molleman, E., 2011. Perceptions of technology uncertainty and the consequences for performance in buyer-supplier relationships. *International Journal of Production Research*, 49(20), pp.6155–6173.
- Osman, M., 2004. An evaluation of dual-process theories of reasoning. *Psychonomic Bulletin & Review*, 11(6), pp.988–1010.
- Paté-Cornell, E., 2012. On “Black Swans” and “Perfect Storms”: Risk Analysis and Management When Statistics Are Not Enough. *Risk Analysis: An International Journal*, 32(11), pp.1823–1833.
- Payne, J.W., 1976. Task complexity and contingent processing in decision making: An information search and protocol analysis. *Organizational Behavior and Human Performance*, 16(2), pp.366–387.
- Pfeffer, J. & Salancik, G.R., 1978. *The External Control of Organizations: A Resource Dependence Perspective*, Stanford, CA, USA: Stanford University Press.

- Poppo, L. & Zenger, T., 2002. Do formal contracts and relational governance function as substitutes or complements? *Strategic Management Journal*, 23(8), pp.707–725.
- Raja, J.Z. et al., 2013. Achieving Customer Satisfaction through Integrated Products and Services: An Exploratory Study. *Journal of Product Innovation Management*, 30(6), pp.1128–1144.
- Reinartz, W. & Ulaga, W., 2008. How to Sell Services MORE Profitably. *Harvard Business Review*, 86(5), pp.90–96.
- Ring, P.S. & Ven, A.H. van de, 1994. Developmental Processes of Cooperative Interorganizational Relationships. *The Academy of Management Review*, 19(1), pp.90–118.
- Sharma, S., Aragón-Correa, J.A. & Rueda-Manzanares, A., 2007. The Contingent Influence of Organizational Capabilities on Proactive Environmental Strategy in the Service Sector: An Analysis of North American and European Ski Resorts. *Canadian Journal of Administrative Sciences (Canadian Journal of Administrative Sciences)*, 24(4), pp.268–283.
- Sloman, S.A., 1996. The empirical case for two systems of reasoning. *Psychological Bulletin*, 119(1), pp.3–22.
- Sloman, S.A., 2002. Two systems of reasoning. In T. Gilovich, D. Griffin, & D. Kahneman, eds. *Heuristics and biases: The psychology of intuitive judgment*. New York, NY, US: Cambridge University Press, pp. 379–396.
- Squire, B. et al., 2009. The effect of supplier manufacturing capabilities on buyer responsiveness: The role of collaboration. *International Journal of Operations & Production Management*, 29(8), pp.766–788.
- Strauss, A.L. & Corbin, J., 1990. *Basics of Qualitative research: Grounded Theory Procedures and Techniques*, Newbury Park, CA, USA: Sage Publications.
- Teigen, K.H., 1988. The language of uncertainty. *Acta Psychologica*, 68(1–3), pp.27–38.
- Tosi, H., Ramon, A. & Storey, R., 1973. On the Measurement of the Environment: An Assessment of the Lawrence and Lorsch Environmental Uncertainty Subscale. *Administrative Science Quarterly*, 18(1), pp.27–36.
- Voss, C., Tsikriktsis, N. & Frohlich, M., 2002. Case research in operations management. *International Journal of Operations & Production Management*, 22(2), pp.195–219.
- Walley, P. & de Cooman, G., 2001. A Behavioral Model for Linguistic Uncertainty. *Information Sciences*, 134(1–4), pp.1–37.
- Weed, S.E. & Mitchell, T.R., 1980. The Role of Environmental and Behavioral Uncertainty as a Mediator of Situation- Performance Relationships. *Academy of Management Journal*, 23(1), pp.38–60.

- Windschitl, P.D. & Wells, G.L., 1996. Measuring psychological uncertainty: Verbal versus numeric methods. *Journal of Experimental Psychology: Applied*, 2(4), pp.343–364.
- Zadeh, L.A., 1968. Probability measures of Fuzzy events. *Journal of Mathematical Analysis and Applications*, 23(2), pp.421–427.
- Zhao, X., Xue, L. & Zhang, F., 2013. Outsourcing Competition and Information Sharing with Asymmetrically Informed Suppliers. *Production and Operations Management*, p.n/a–n/a.
- Zimmermann, H.-J., 2000. An Application-oriented View of Modeling Uncertainty. *European Journal of Operational Research*, 122(2000), pp.190–198.

Tables and Figures

Table 1: Uncertainty in inter-organisational relationships

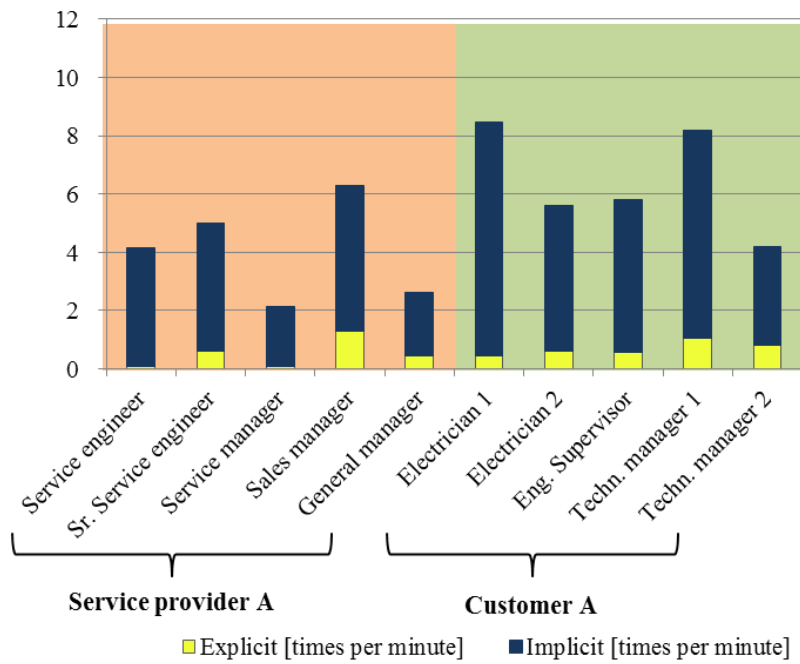
Possible issues	Uncertainty arises from ...	Uncertainty type
Technological development	Rate of technological change within the industry which may stem from technological developments or changes in the standards or specifications of products and creates the possibility of obsolescence of the product or parts (Oosterhuis et al. 2011)	Environmental uncertainty
Availability of material	Suppliers are unable (or unwilling) to accurately predict the “quantity and timing of supply“ (Fynes et al. 2004, p.183) which means that material, parts or tools needed for service provision may be unavailable at the time of	Environmental uncertainty
Service demand and cost	Demand for services as the amount and timing of interventions may be unpredictable due to the fact that the customer’s diligence, commitment and responsibility may be unknown (Fynes et al. 2004). This leads to variability of the cost of providing the service (Zhao et al. 2013)	Relational uncertainty
Information sharing	The exchange of confidential and private information increases the vulnerability of the organisations to possible information leakage to unintended parties (Zhao et al. 2013). This depends on the level of trust between the parties (Ring & Ven 1994) as well as the level of cooperation (Das & Bing-Sheng 1996),	Relational uncertainty
Service capability	The service provider may experience a “difference between the amount of information required to perform the task and the amount of information [it] already possesses” (Galbraith 1977, p.36). This is connected to the nature of the task such as task structure, lead time to completion, ambiguity of the aim of the task or the interdependence of work units (Weed & Mitchell 1980; Krishnan et al. 2011).	Organisational uncertainty
Service performance	The performance of the service agreement and its contribution to the organisation’s strategic goals may be unpredictable (precisely) (Ring & Ven 1994; Das & Bing-Sheng 1996)	Organisational uncertainty

Table 2: Interviewees for both case studies

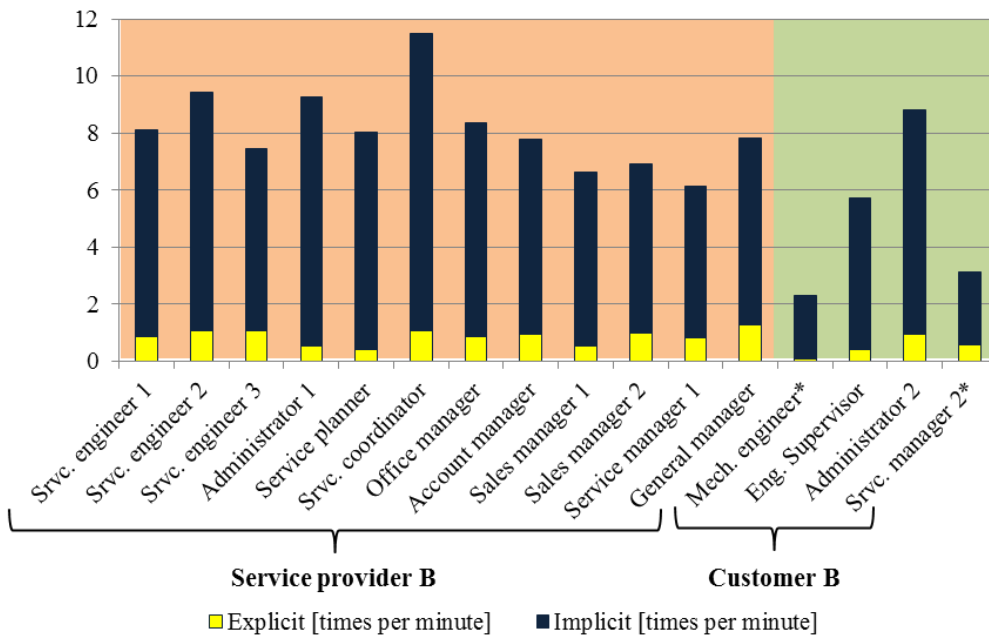
	Case A		Case B	
	Title	Experience	Title	Experience
Service provider (SP)	Service engineer	4-5 years	Service engineer 1	6 years
	Sr Service engineer	9 years	Service engineer 2	9 years
	Service manager	23 years	Service engineer 3	25 years
	Sales manager	32 years	Administrator 1	6 years
	General manager	5 years	Service planner	8 years
			Service coordinator	6.5 years
			Office manager	5 months
			Sales manager 1	1 year
			Sales manager 2 (semi-retired)	24 years
			Accounts manager	5 years
			Service manager 1	10 years
			General manager	1.5 years
Customer (C)	Electrician 1	20 years	Mechanical engineer	2.5 years
	Electrician 2	6 years	Engineering Supervisor	9 years
	Technical manager 1	5 years	Administrator 2	2 years
	Technical manager 2	3 years	Service manager 2	9 years
	Eng. Supervisor	6 years		

Table 3: Terminology indicating explicit and implicit awareness of uncertainty

Code	Terms included with exemplar references
Explicit uncertainty	<p>Uncertain, uncertainty; risk, risky (Knight 1921); chance (Keynes 1921); $x\%$, probable, probability, probably including probabilistic uncertainty modelling such as Sensitivity analysis or Monte Carlo (Keynes 1921), likely, unlikely (Kahneman & Tversky 1982);</p> <p>variation, vary, variable (Downey et al. 1975); imprecise, imprecision (Keynes 1921); ambiguous, ambiguity (Ellsberg 1961); vague, vagueness, vaguely, fuzzy (Zadeh 1968); interval statement (e.g. maximum, minimum, worst case, best case, biggest, smallest, heaviest, lightest) (Moore 1966), not clear, unclear, clarify, clarification, clarity (Zadeh 1968), not defined, undefined, not definite (Zadeh 1968); on average, mean, around (Keynes 1921);</p> <p>confident, confidence, not confident (Kahneman & Tversky 1982); unknown, not known, do not know (Keynes 1921), not understand, not understood (Kaplan & Garrick 1981); ignorance, ignore, ignorant (Kahneman & Tversky 1982); not sure, unsure (Kaplan & Garrick 1981); possible, impossible, not possible, possibly (Teigen 1988)</p>
Implicit uncertainty	<p>change, changed (Dequech 2011); maybe, perhaps (Hurley et al. 2011); expected, expect, expectation, expectedly, unexpected (Zimmermann 2000); potential, potentially (Dequech 2011); if ... then, in case, depending on, depend on, alternative, alternatively, otherwise (Dequech 2011); different, differently (Kreye et al. 2012); suggest, suggestion, suggested (Grant 2007); almost, most (Kreye et al. 2012); undecided, not decided (Goh et al. 2010); predict, forecast, estimate (Goodwin 2002); guess, think, wonder, thought, reckon, imagine (Grant 2007); may, could, can, might (Hurley et al. 2011); suppose, supposed to, supposedly (Harvey 2001); assume, presume, presumably, presumed (Kreye et al. 2012); lack of ..., not enough, missing (knowledge, information, data etc.) (Zimmermann 2000); available (data, information, evidence etc.) (Walley & de Cooman 2001); confusing, confused, confusing (Hurley et al. 2011); experience, inexperience, inexperienced (Barnett & Breakwell 2001); vagueness in statement (some sort of ..., seem to ...) (Grant 2007); common, not common, commonly, usually, usual, typically, typical, normal, regular (Kreye et al. 2012); disagree, disagreement, not agree (Walley & de Cooman 2001); re- (renegotiate, reschedule etc) (Kreye et al. 2013); mis- (miscommunicate, misunderstand etc) (Grant 2007)</p>

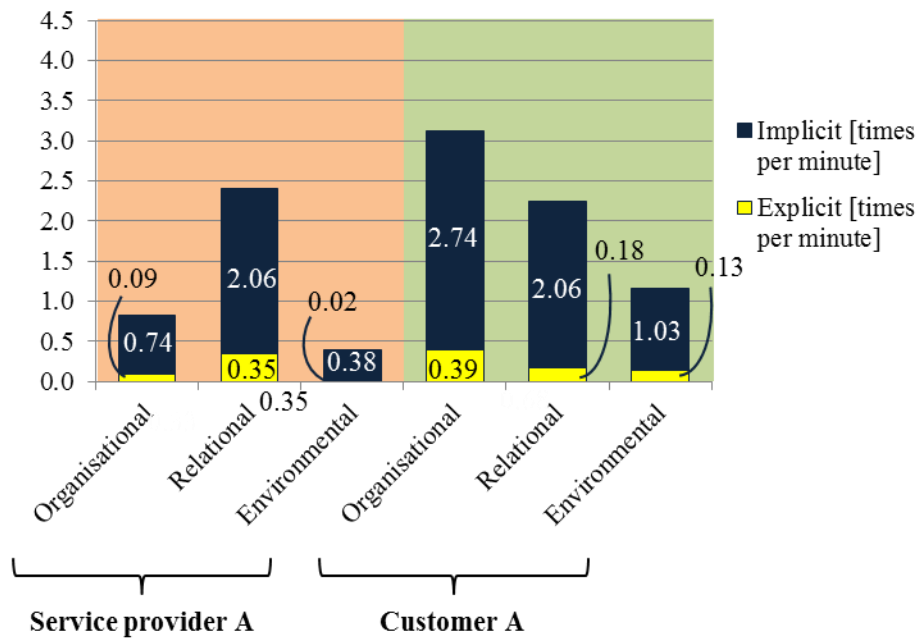


a) Uncertainty perceptions for Case A

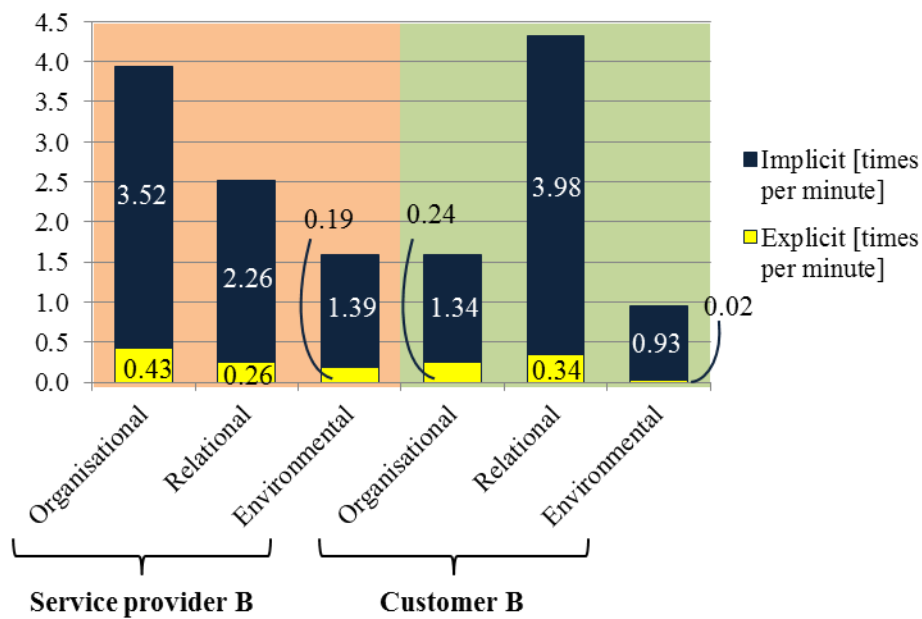


b) Uncertainty perceptions for Case B

Figure 1: Measured uncertainty perceptions and individual differences for the two cases



a) Uncertainty types for Case A



b) Uncertainty types for Case B

Figure 2: Measured uncertainty perception for the three uncertainty types